PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in or relating to Friction Transmission.

I, FRANK ANDERSON HAYES, a citizen of the United States of America, of Middletown Township, Monmouth County, State of New Jersey, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates in general to variable speed friction transmissions of the toroidal disk type in which a plurality of rollers or "wheels" have frictional driving contact with toroidal grooves of circular cross section formed in the disks.

The present invention relates more particularly to the nature and degree of the wear between the rollers and the disks. Such wear is naturally dependent upon the spacing of the disks and the pressure between them and upon variations of such pressure, and it is therefore important to provide simple and effective means for determining the spacing of the disks and the pressure between them.

The motive force used to drive transmission of the kind referred to is usually of the constant torque type, that is a prime mover such as a gas engine in which the maximum torque is fairly constant over a wide range of speed, or a more or less constant speed type having a relatively low overload factor such as an induction motor, or one of the shunt wound continuous current type. In either case the transmission must be provided with pressure enough to take care of the maximum torque of the prime mover at the lowest speed ratio of the transmission. This may be more than ten times the high speed requirement depending upon the range of the transmission, so that for uses such as in motor vehicles, where a large part of the operation is in the high speed range, a transmission of this type provided with a simple spring arrangement for applying the required pressure would operate most of the time at much higher pressure than required, with consequent low efficiency, overheating and deterioration.

According to one feature of the present invention I obtain variations in axial pressure between the disk by providing a construction in which such variations are brought about by the movement of the rollers themselves in rocking from higher to lower speed ratio positions and vice versa. A further feature consists in utilising the rollers themselves to bring about variations in axial separation of the disks.

In the construction hereinafter more fully described the variations in separation of the disks and in pressure between them are produced by off-setting the grooves in the two races with respect to the rollers, i.e. by locating the groove in the driving or low torque race farther from the disk axis than that in the driven or high torque race. This has the effect, in a radial section through the races, of off-setting the cross-sectional curves or making them eccentric with respect to each other and to the friction roller which is normally placed midway between the two race curve centers. Then as the roller precesses or rocks from the high speed to the low speed position, the two races are spread apart, thereby compressing the spring (which urges the disks toward each other) and giving the necessary additional pressure. The actual curve of spring deflection or speed ratio may be further modified by making the roller diameter slightly different from that of the race contours. Thus if the roller is made larger, the pressure for the mid-speed or parallel position of the rollers will be reduced with respect to that for the extreme positions and vice versa.

The life of the rollers themselves may be prolonged by causing each roller to make contact with the disks on more than one circle of contact or tread on the roller, irrespective of any variation of spacing of the disks or of pressure between them. The prolongation of life obtained in this way as hereinafter described is due in part to a wider distribution of the wear due to traction, but in a greater degree to the reduction in rate of fatigue of the metal due to pulsating stresses on the rollers.

The accompanying drawing is a longi-

tudinal section and represents more or less diagrammatically a simple form of toroidal disk variable speed transmission.

In the present instance, 1 designates the driving or low-torque disk secured to shaft 3 by a key 10 and 2 is the driven disk floating on the shaft 3 and connected in any suitable manner to the machine intended to be driven at variable speed, or the disk 2 may be held stationary by some suitable means and the rollers operated in a planetary manner. A number of methods for supporting and articulating the roller 11 have been described in the prior art and as they are all applicable to my invention, they are omitted for the sake of simplicity.

The annular grooves or races of the disks are designated by 12 and 13 and the center of the race profile or contour 13 is shown at *a*, *o* being the center of the roller and the axis about which the roller swings or precesses to change the speed ratio. The center of the race contour 12 is *c*, the radius of contour of the roller face being r^1 and that of the disk races *r*. The diameter of the race or groove 13, from the center *a* through the axis of shaft 3 to the corresponding center on the other side of the disk, is therefore greater than the corresponding diameter of race 12. It should be noted that r^1 is less than *r* and should be so chosen with reference to *w* (the width of face of the roller) that the contact point b^1 (found by producing line *a*—*b* to b^1 and *c*—*d* to d^1) is always within the face of the roller. It will be seen that the circle of contact on the roller passing through b^1 is offset and always to one side of the median plane of the roller, as indicated at H, while the corresponding contact portion of the roller for the disk 2 is on the opposite side. This is a great advantage as it materially increases the available contact area of the roller and thus greatly prolongs its life.

The high speed position of the roller 11 is shown by the full lines, whilst the low speed position is shown by the broken lines, and it will be seen that in the latter position the disks are axially separated by the roller, because of the eccentricity of the races, when said roller is moved from the high to the low speed position. This axial separation of the disks results in a compression of the spring means 4, 4*a*, thus increasing the spring pressure against the disks when the roller is in that position and correspondingly increasing the frictional contact between the driving elements when operating at low speed. If *e* as shown is the eccentric displacement (relative to the centers *a* and *c*) of the axis on which the roller rocks to effect speed changes, then the total axial movement of the disks as the roller swings from high to low speed with a maximum angle of 45 degrees either way from the mid position is approximately four times *e*.

A duplex spring means (4, 4*a*) has been shown in the drawings, but a single spring may be used to advantage if found more desirable. The spring means may be mounted so as to engage the collars 7, 7*a* on the shaft 3 and anti-friction bearings 5, 6 and 5*a*, 6*a* may be interposed between the springs and the disks so as to lessen the friction at this point.

Variations may be resorted to within the scope of the invention as defined by the appended claims.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A variable speed friction transmission mechanism having a pair of annularly grooved co-axial disks, rollers in frictional contact with the groove surfaces, and means exerting axial pressure on the disks towards each other, characterised by the fact that in changing the speed ratio the movement of the rollers in rocking from higher to lower speed ratio positions and vice versa has the effect of varying the said axial pressure.

2. A variable speed friction transmission mechanism having a pair of annularly grooved co-axial disks, rollers in frictional contact with the groove surfaces, and means exerting axial pressure on the disks towards each other, characterised by the fact that in changing the speed ratio the movement of the rollers in rocking from higher to lower speed ratio positions and vice versa has the effect of varying the axial separation of the disks.

3. A variable speed friction transmission mechanism comprising a pair of co-axial disks adapted for axial separation and provided with concave raceways of toroidal formation which are relatively offset in a transaxial plane, a friction roller engaging said raceways and movable to change the driving ratio, and a pressure means acting axially on the disks, said pressure being adapted to be intensified by the action of the roller on said raceways when the roller is moved to a low speed position.

4. A variable speed friction transmission mechanism as claimed in claim 1, 2 or 3, in which the grooves are of the toroidal type and the profile centers of one groove are farther from the disk axis than are the profile centers of the other.

5. A variable speed friction transmission mechanism as claimed in claim 4, in which the profiles of the grooves are circular arcs.

6. A variable speed friction transmission mechanism according to claim 4, in which the rollers are arranged with their centers between the profile centers of the grooves.

7. A variable speed friction transmission mechanism according to claim 4 in which the disk having the profile center of its groove farther from the disk axis constitutes the driving disk.

8. A variable speed friction transmission mechanism of the type having a pair of toroidally grooved disks and transmission rollers adjustable angularly to vary the speed ratio of the mechanism, in which the diameter of the groove in one of the disks between the centers of curvature of the groove profile is greater than the like diameter of the groove in the other disk.

9. A variable speed friction transmission mechanism having a pair of annularly grooved co-axial disks, rollers in frictional contact with the groove surfaces, and means for maintaining pressure between the disks and the rollers, characterised by the fact that the relative curvatures of the roller surfaces and of the groove surfaces are such that each roller makes contact with the respective disks on more than one circle of contact or tread on the roller.

10. A variable speed friction transmission mechanism according to any of the preceding claims, in which the curvature of the roller surfaces relatively to the groove surfaces is such that each roller touches the respective disks on two separate tracks spaced on opposite sides of the median plane of the roller.

11. A variable speed friction transmission mechanism of the toroidal disk type, having its parts constructed, arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings and for the purpose specified.

Dated this 17th day of April, 1931.
For FRANK ANDERSON HAYES,
White, Langner, Stevens, Parry & Rollinson,
Chartered Patent Agents,
5—9, Quality Court, Chancery Lane,
London, W.C. 2, and at
17, John Street, New York, U.S.A.

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